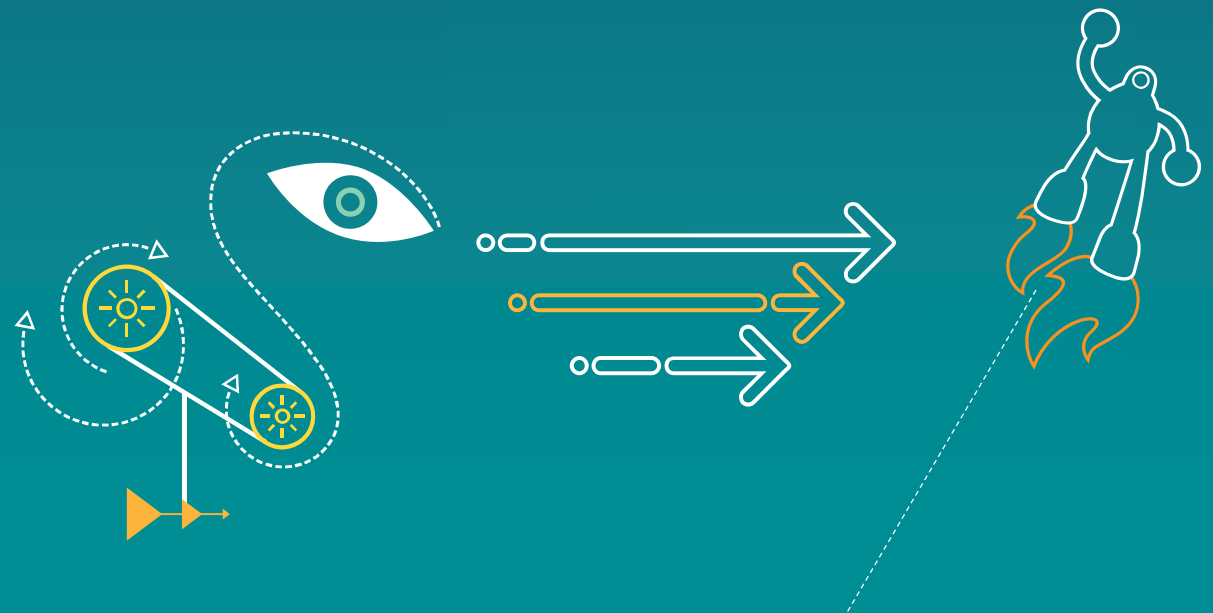
The Wi-Fi Evolution

An integral part of the wireless landscape

QUALCOMM®



Wi-Fi: An integral part of the wireless landscape

Part of the solutions to “1000x mobile data challenge”

Wi-Fi supported in all smart devices

At the center of connected home

The universal technology for smart connected homes

Opening new frontiers for wireless connectivity

Wireless Display

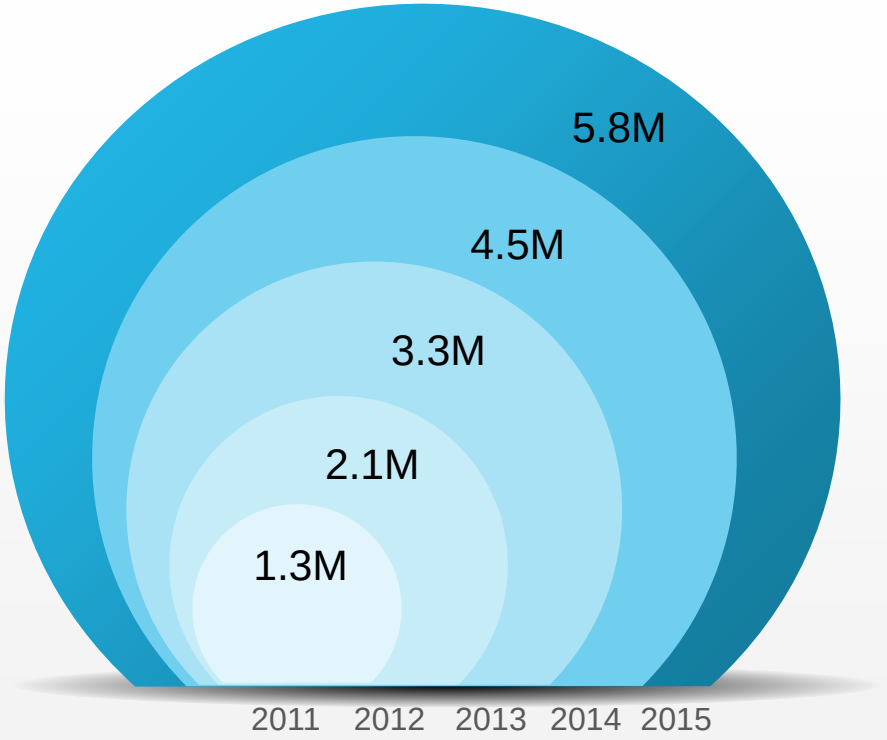
Peer-to-peer

Indoor Location

Leveraging ubiquity of indoor Wi-Fi for many new applications and services

Wi-Fi is becoming ubiquitous

Growing Global Reach



Number of public hotspots worldwide.

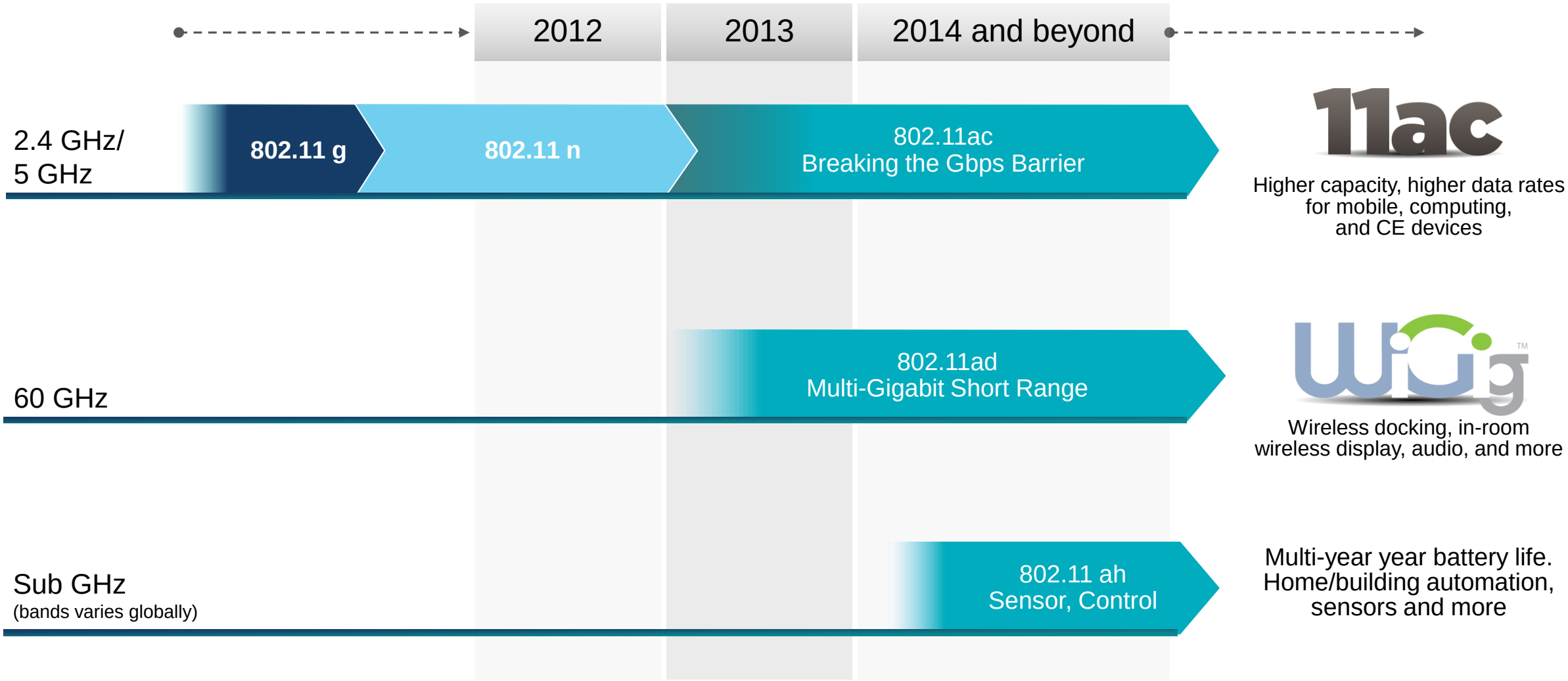
Source: Wireless Broadband Alliance (WBA) and Informa Telecoms & Media.

Expanding Device Support

Wi-Fi Enabled Devices Shipped	2012 MU	2015 MU
Phones/Accessories	685	1,459
Tablets, E-Readers, Media Players, etc	199	360
Laptops, Desktops, Peripherals, etc.	392	717
Connected Home	107	287
Others	39	338
TOTAL	1,422	3,161

Source: ABI Research forecast, December 2012. “Connected Home” category includes Flat Panel TVs, Set-top Boxes, Gaming Consoles, Gaming Console Controllers, DVD/Blu-ray Players/Recorders, OEM Remote Controls,3D Glasses, Digital Photo Frames. “Others” include Automotive Health, Fitness and Medical, Smart meters, automation, industrial

A strong Wi-Fi evolution path



Qualcomm VIVE™: Enabling end-to-end 11ac ecosystem

Driving 11ac in migration in mobile through pin compatible solutions

Extending industry leading Wi-Fi performance[1]

~6x lower power consumption (v/s our own 11n)

[1]AnandTech -The HTC One X for AT&T Review by Brian Klug on 5/1/2012; “Unsurprisingly the One X posts the highest WLAN throughput I’ve seen from a smartphone to date.” ; This devices uses Qualcomm’s 802.11n solution

End-to-end portfolio maximizing 11ac benefits

Mobile

- 1-stream 11ac
- Integrated BT 4.0 & FM
- 433 Mbps capacity
- Dual-band 5/2.4GHz

Smartphones & Tablets

Computing

- 1-, 2- and 3-stream 11ac
- Integrated Bluetooth
- 433, 866 Mbps & 1.3 Gbps
- Dual-band for all solutions

Tablets, Notebooks, AIOs

Consumer electronics

- 2-, 3-stream 11ac
- Integrated Bluetooth
- 866 Mbps & 1.3 Gbps
- Dual-band, dual-concurrent

Handsets, Gaming, eReaders, DTV, STBs, PNDs

Networking

- 2- and 3-stream 11ac
- 866 Mbps & 1.3 Gbps
- Integrated processor & switch
- Dual-band for all solutions

Switches, Routers, Gateways, PLC, Femto

11ac

3G/4G/Wi-Fi
Smallcells/Hetnet

Seamless
3G/4G/Wi-Fi Interworking

Wi-Fi: Part of the solutions to the "1000x Mobile Data Challenge"

Mobile data traffic growth—industry preparing for 1000x

Preparing for

1000x

Data traffic growth

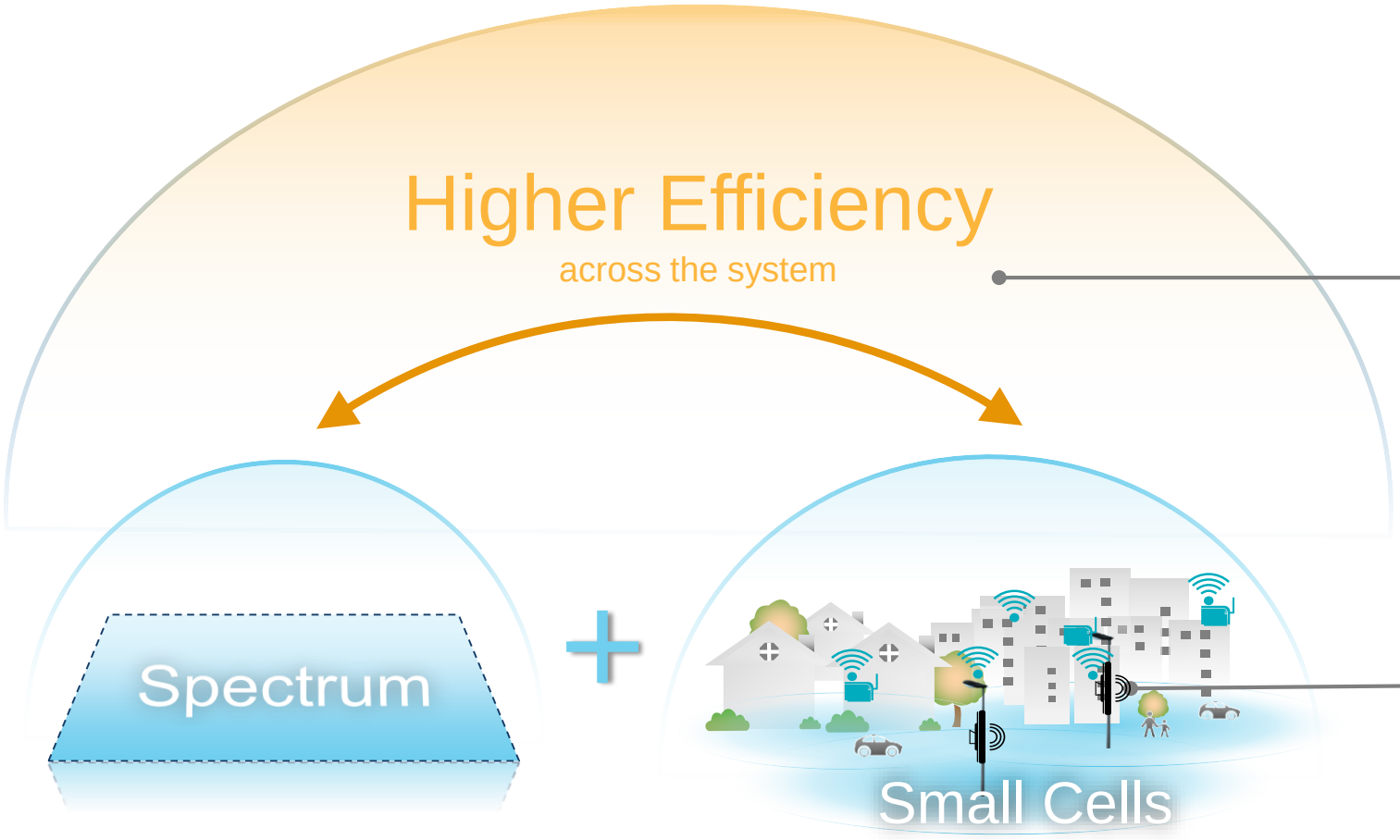
Global data traffic growth

~2x

From 2010- 2011*

*Global growth, some regions grew more/less

Multiple efforts needed to address 1000x – Wi-Fi is an integral part of the solutions



11ac

Next-Gen Wi-Fi with 3x more throughput (per stream)

Wi-Fi/3G/4G Seamless interworking for selecting best access

Wi-Fi to be integrated into virtually all 3G/4G small cells

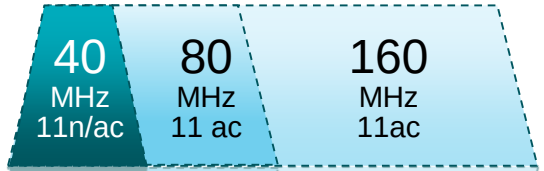
802.11ac: Up to 3x increase in throughput per stream

3x more in the future with MU-MIMO

- 3x throughput now*
- 3x more aggregate throughput with MU-MIMO**
- Higher data rates at all ranges
- Lower latency

11ac

Wider Bandwidth



- Up to 80 or 160 MHz per channel
- Less crowded 5GHz band
- Higher order modulation (256 QAM)

Dynamic Bandwidth Management

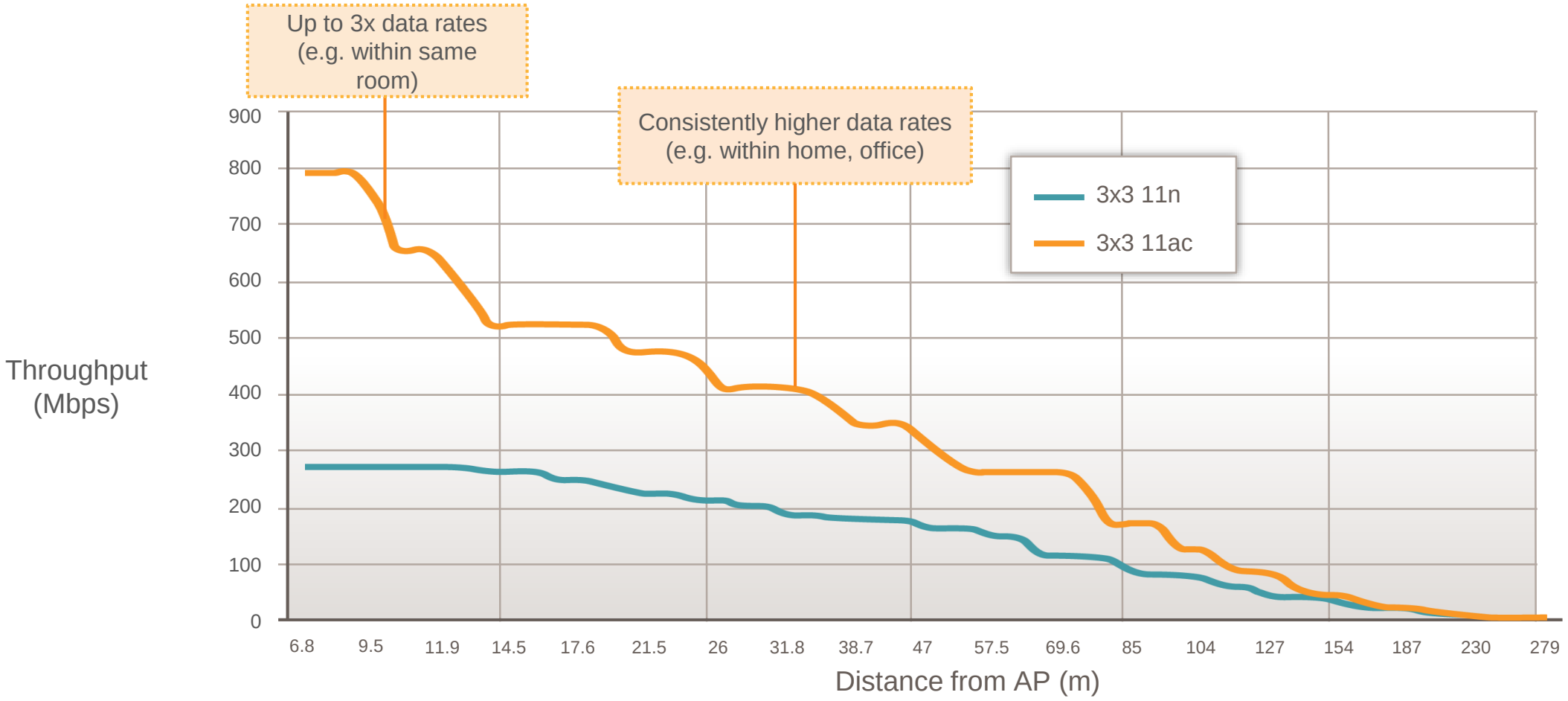
- Improved interference detection and avoidance
- Bandwidth allocation based on interference

Multi User MIMO

Serves up to 3 devices simultaneously

* As compared to 802.11.n; **When compared to 3-stream 11ac SU-MIMO, considering only single stream mobile devices; 802.11ac standard supports up to 8-stream MIMO

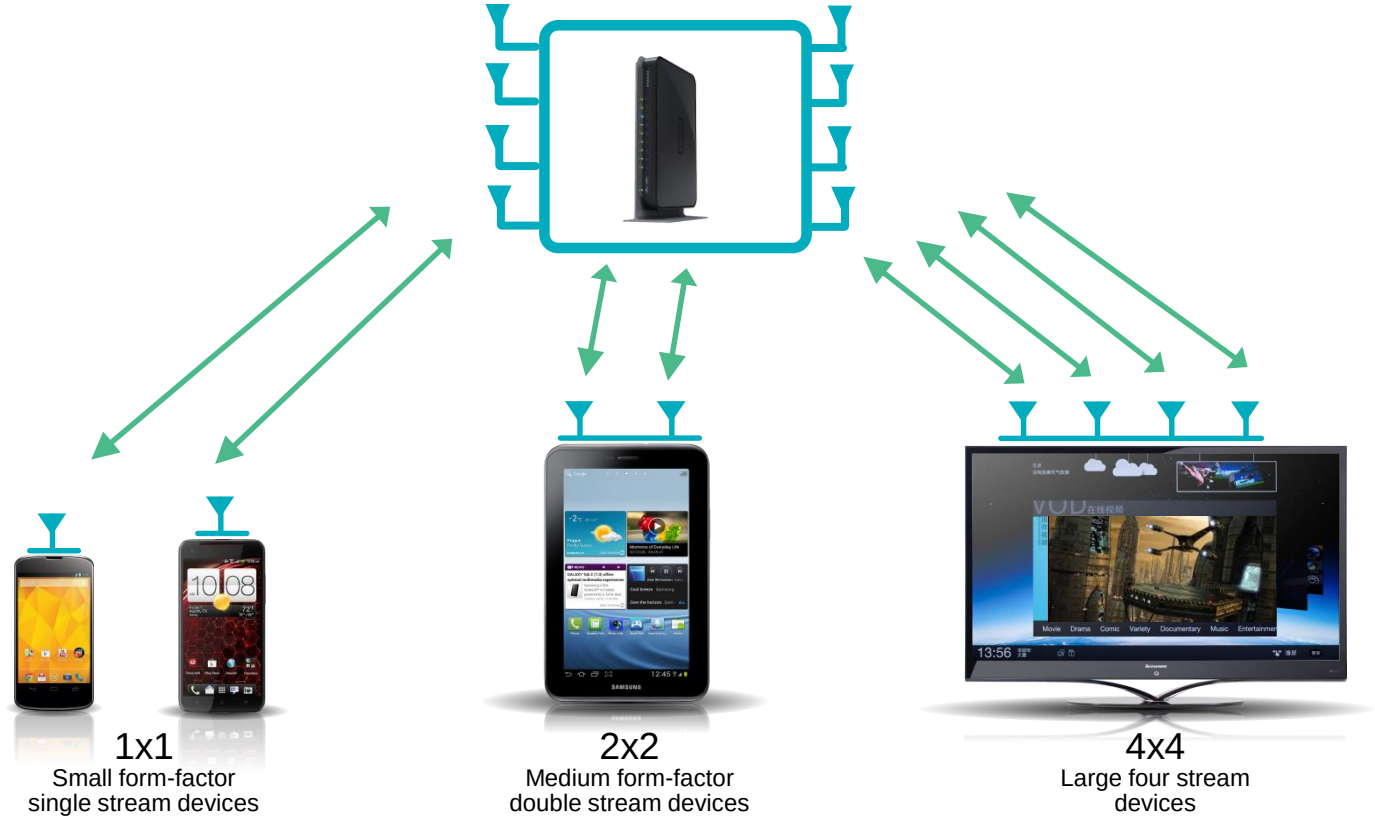
802.11ac: Higher data rates at all ranges

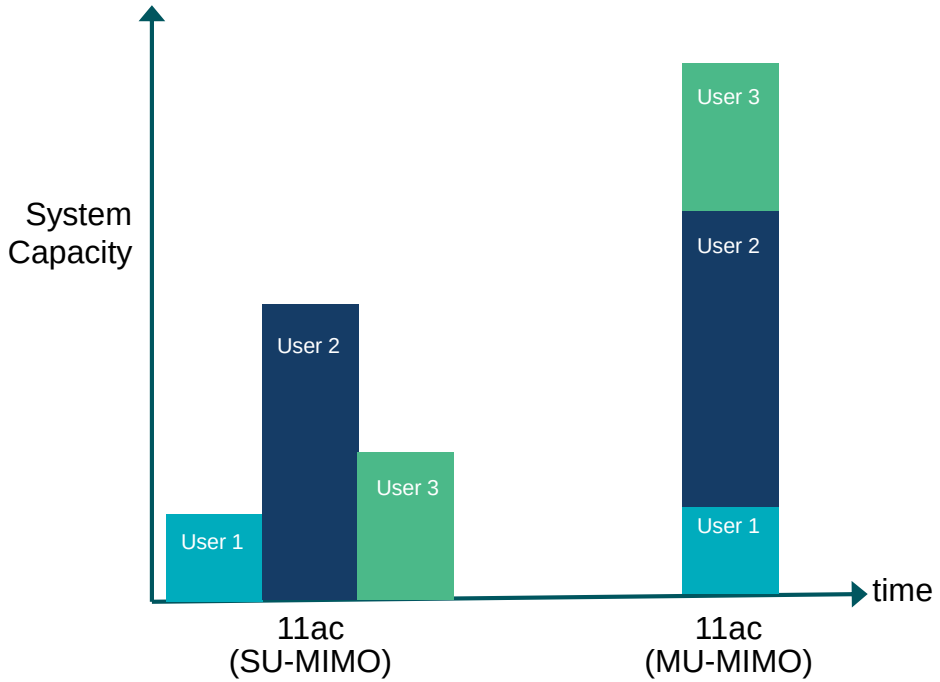


Source – Qualcomm simulations; Assumptions - TCP/IP Throughput, Channel model D, 5GHz 11ac is 80MHz 3x3 3SS with ML and LDPC; 11n is 40MHz 3x3 3SS with ML and LDPC

MU-MIMO: Higher capacity with mix of devices

Simultaneously serving multiple devices by reusing resources



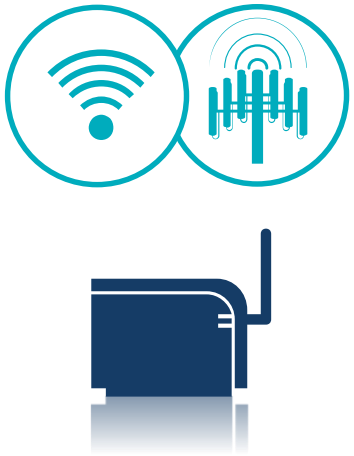


Simultaneously serves up to 3 devices

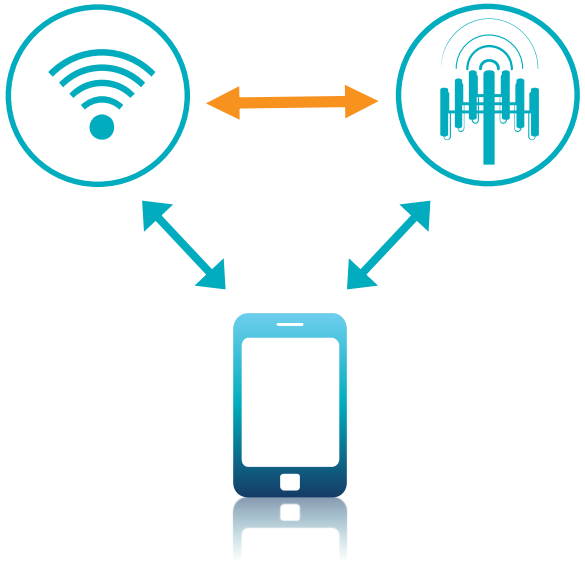
Up to 3x more aggregate throughput*

*When compared to 3-stream 11ac SU-MIMO, considering only single stream mobile devices

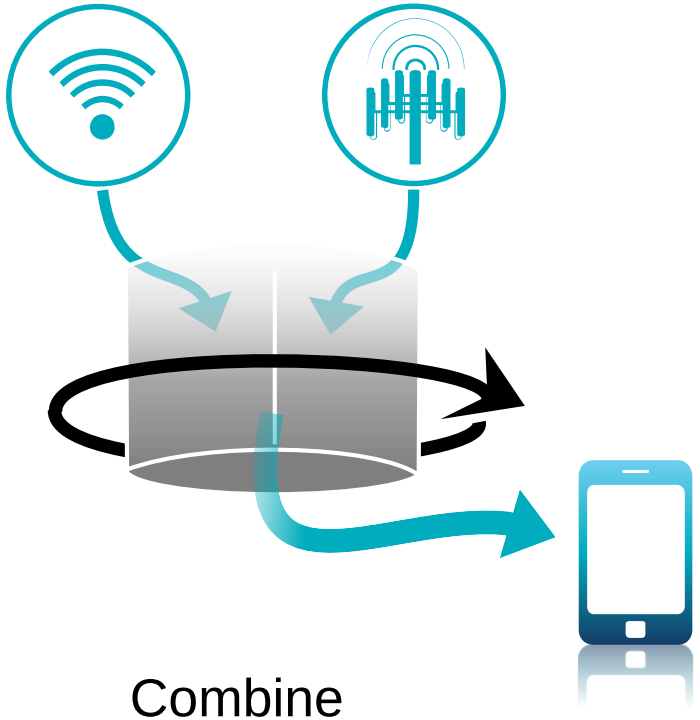
Tighter Wi-Fi—3G/4G interworking



Convergence of Cellular and Wi-Fi Infrastructure

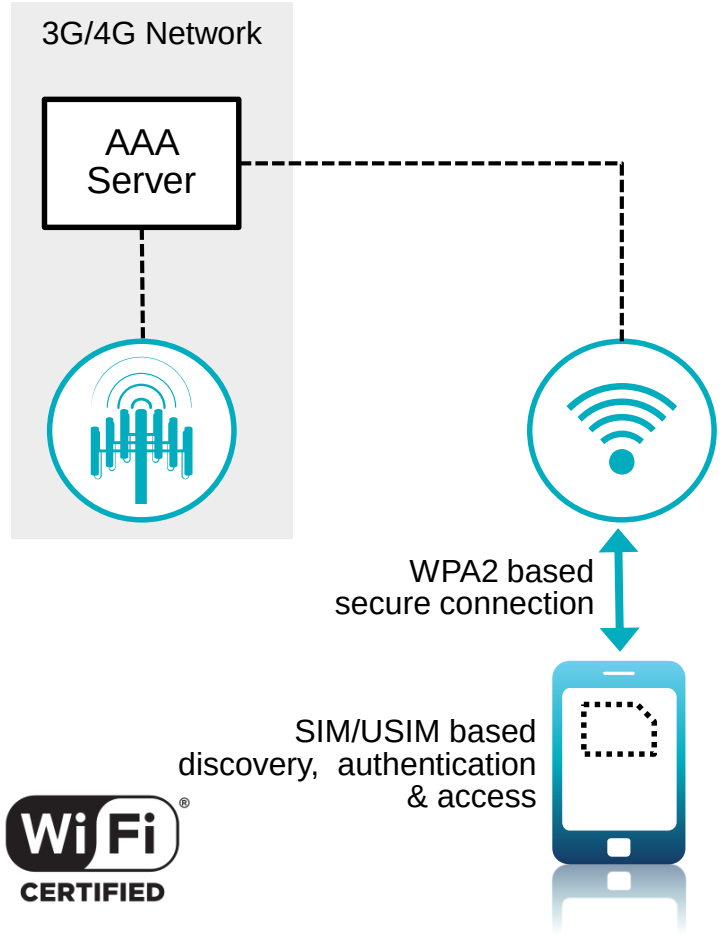


Seamless Access and Connectivity



Combine Wi-Fi and 3G/4G

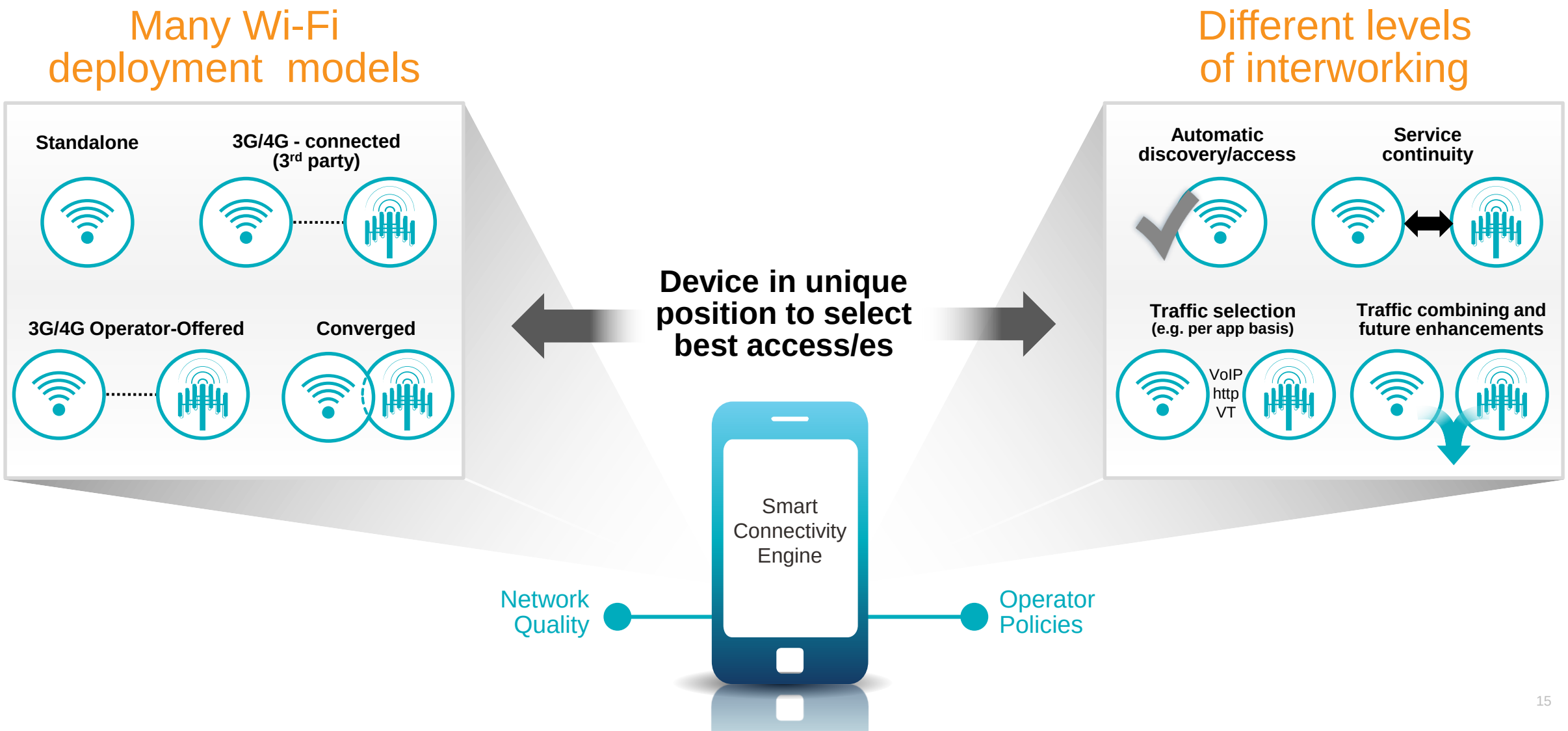
Passpoint™ – Seamless 3G/4G/Wi-Fi roaming



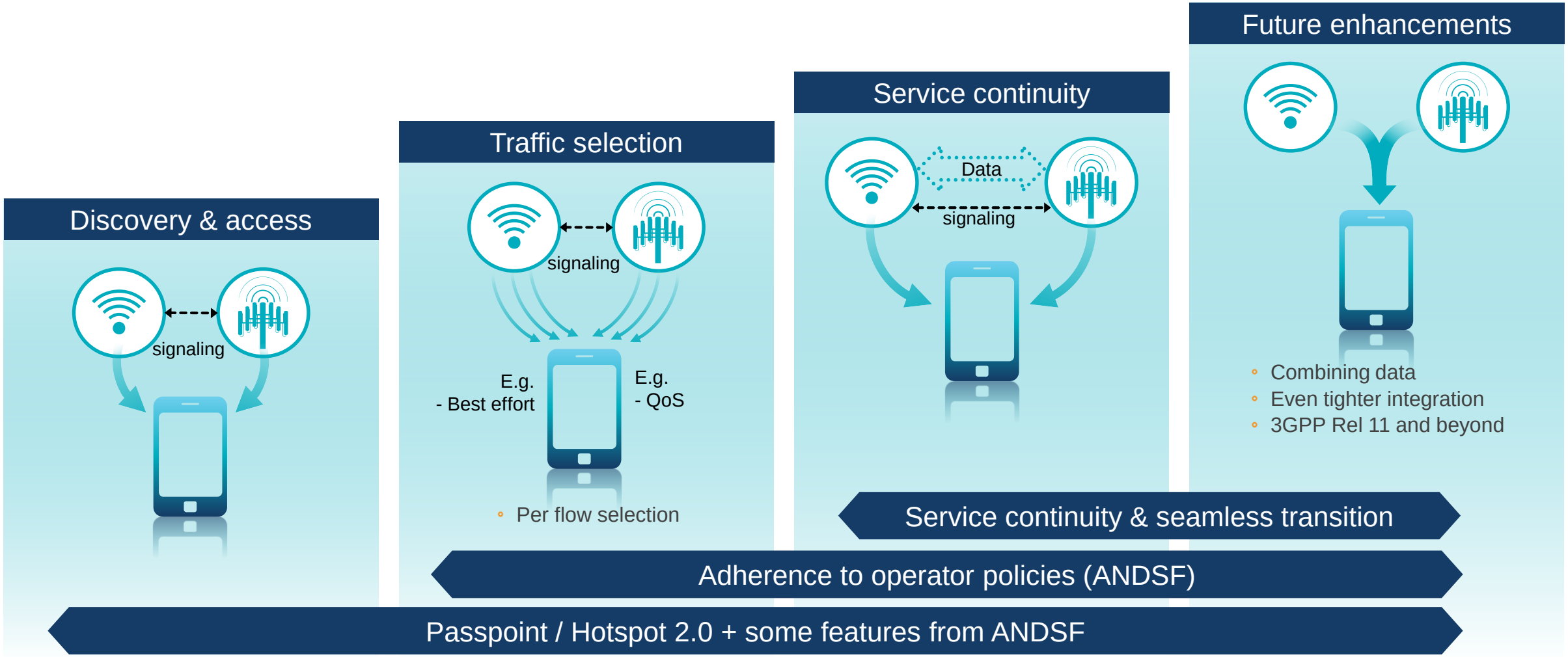
- Automatic discovery and access
  - No user intervention
  - Single set of credential for all hotspots
  - 3G/4G/ SIM/USIM based authentication
- Proven WPA2- Enterprise security
- Roaming among Wi-Fi and between 3G/4G Wi-Fi networks
- Deployments in 2013

Passpoint™ is known in standard as Hotspot 2.0

Multi-dimensional Wi-Fi—3G/4G interworking landscape



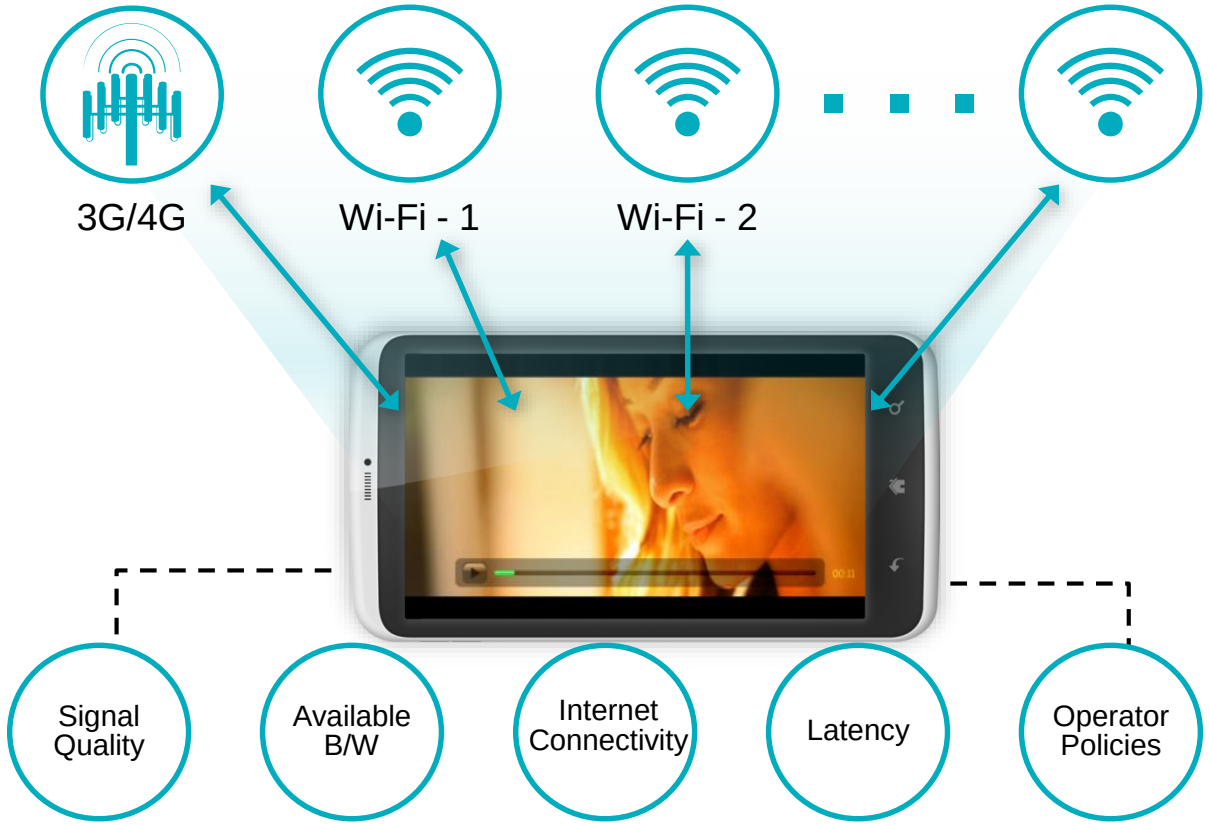
Seamless Wi-Fi—3G/4G interworking is evolving



Notes: 1) ANDSF - Access Network Discovery and Selection Function defined in 3GPP :
2) The evolution shown here represents the trend in commercialization. 3GPP supports Service continuity in Rel 8 and Traffic selection in Rel. 10

Qualcomm connectivity engine (CnE) – Selecting best access

Based on end-to-end link performance



Standards compliant
(Passpoint/Hotspot2.0, 3GPP (ANDSF), IWAN)

Smart algorithms
(In addition to standards)

Part of Qualcomm chipset solutions

Qualcomm 3G/4G – Wi-Fi converged small cell Solutions

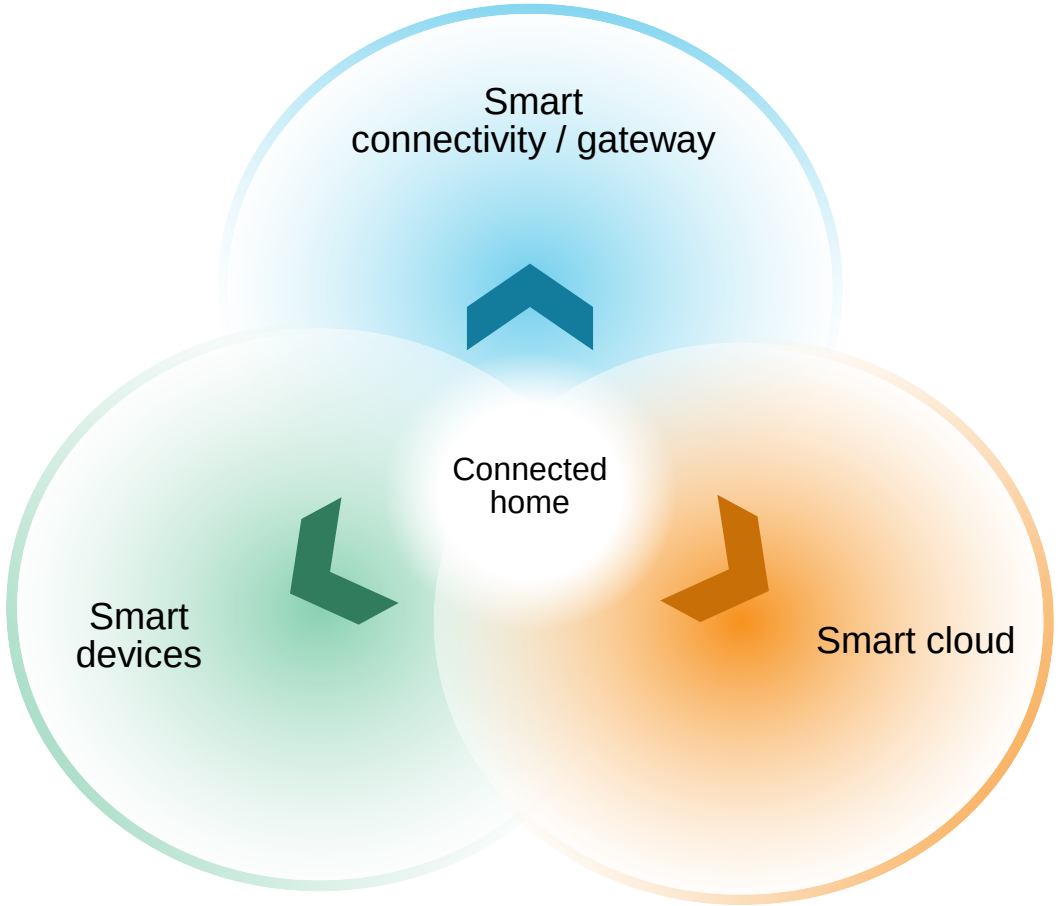
- Highly integrated SoC
  - 3G/4G, Wi-Fi (11n & 11ac)
- Complete reference designs
  - Modular, Flexible RF band support
  - RF Coexistence considerations fully addressed
- Intelligent end-to-end connection management
  - Hotspot 2.0/Passpoint support
  - Access selection based on information from both Wi-Fi and 3G/4G (QoS, resource constraints, loading, link quality etc)
  - Works even better with Qualcomm's connectivity engine (CnE)

	Qualcomm's Converged Small Cell	**Standard Converged Small Cell**
Device with CnE	**Most optimized selection with end-to-end information**	**Intelligent selection based only on device info**
Device w/o CnE	**Intelligent selection based only on AP info**	**N/A**

Wi-Fi: At the center of “Smart Connected Homes”

Connected home vision: Multiple smarts working together

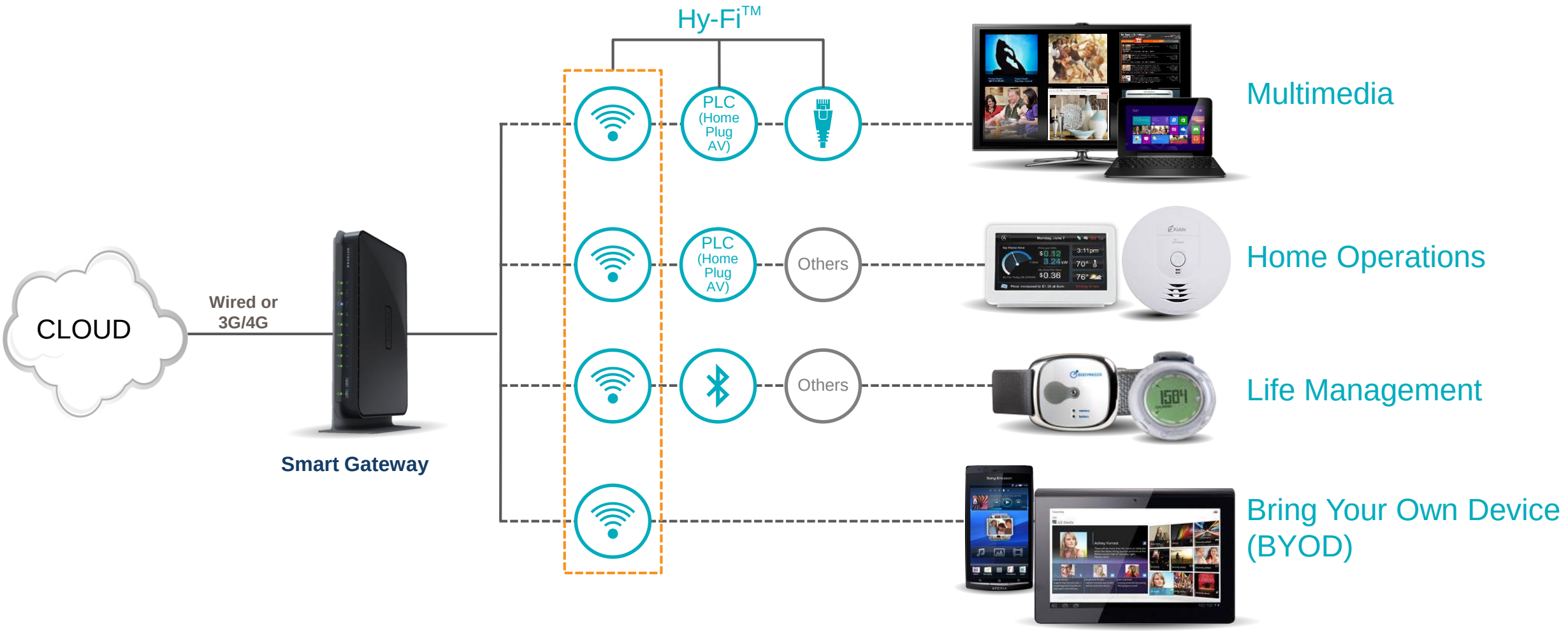
Manage devices/apps to maximize efficiency, and provide homogenized user experience
(e.g. smart bandwidth management based on app requirements)



Deliver a personalized connected home experience
(e.g. smart TV, smart appliances)

Extend resources of the home network when needed, by providing additional data, storage space and computing capabilities

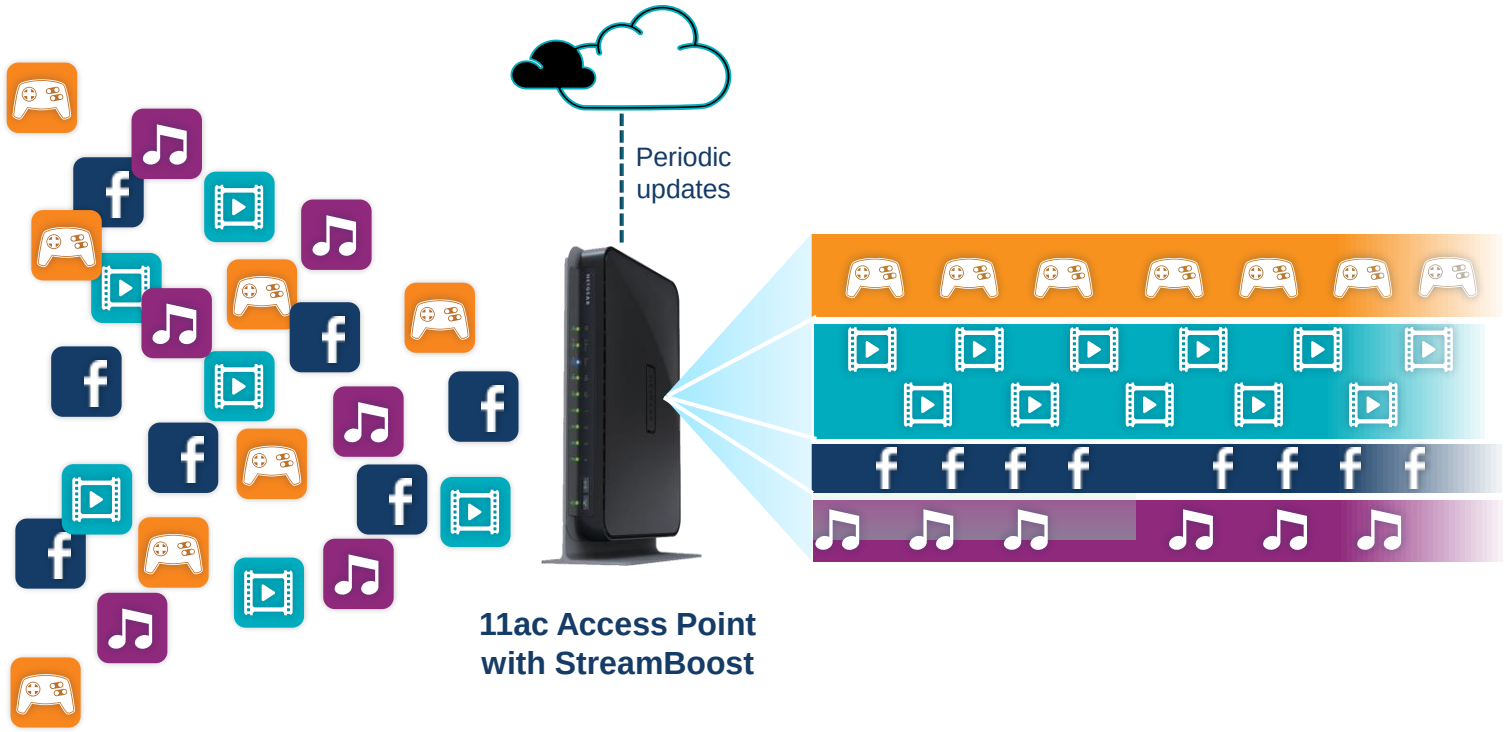
Wi-Fi: Universal technology in “Connected Homes”



PLC – Power Line Communications
Home Plug AV – Standard for Audio/Video over PLC

StreamBoost™ : Taking 11ac to the next level

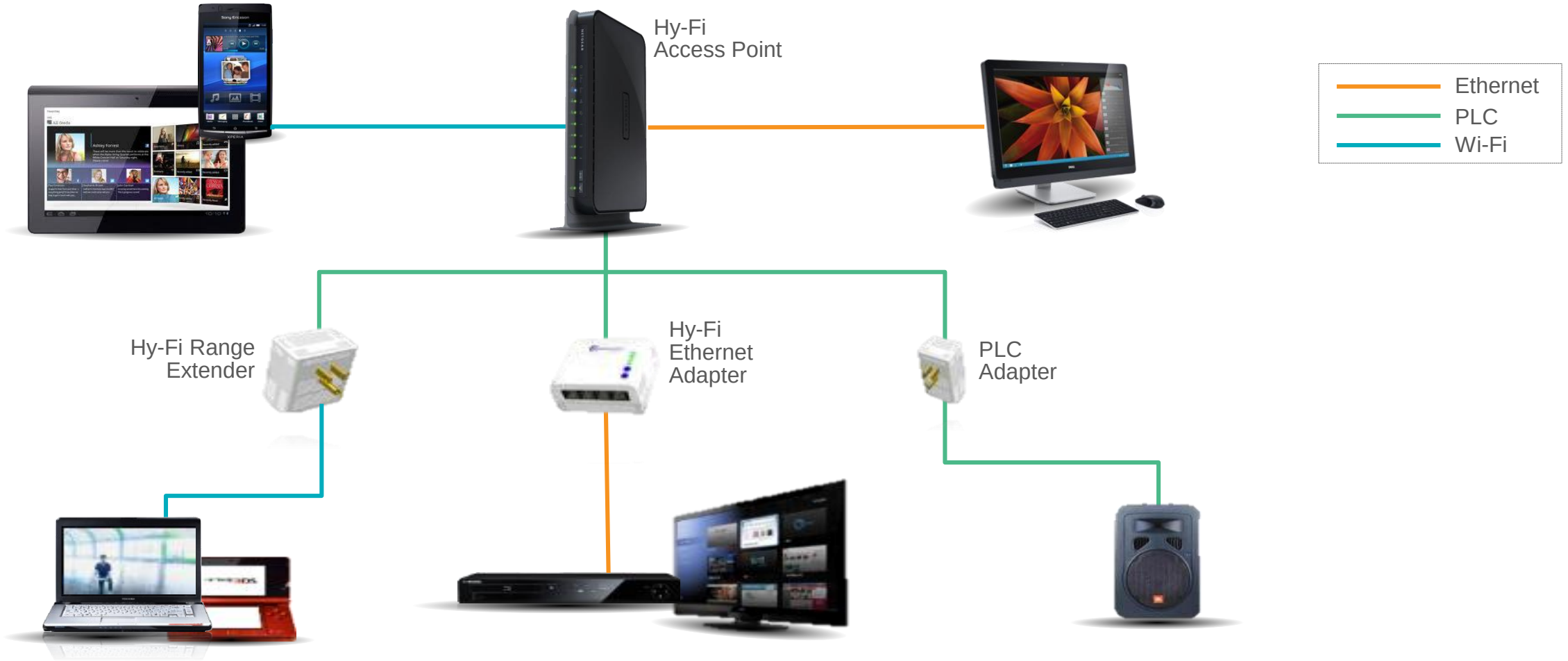
Intelligent traffic management for best possible performance



- Allocates appropriate bandwidth to each app/device for the best experience
- Makes the most of the finite available bandwidth
- Cloud-based updates continue to optimize network performance
- Supported in *all* ViVE networking chipsets

Qualcomm Hy-Fi™: Combining Wi-Fi, PLC and Ethernet

Mobility and flexibility of Wi-Fi with reliability and range of PLC



Wireless Display

Indoor Location

Wi-Fi: Opening new frontiers

Wi-Fi : Foundation for all wireless display technologies

Wi-Fi display solutions
(e.g AllJoyn™ based media shifting apps, Skifta, and others)

802.11 n/ac

or

802.11ad (future)

All wireless display solutions use Wi-Fi

Miracast™

Global industry standard for Wireless Display

- Mandatorily uses Wi-Fi Direct
- Captures contents of source display and renders on the target
  - Mirrors the entire display, not just “transferring” media

WiGig: Short-distance multi-gigabit connectivity

Leveraging bandwidth-rich 60 GHz spectrum with 802.11ad

Wireless Gigabit Alliance

Globally Harmonized Band
(Up to 9 GHz available in most countries)

Complements 11ac
(for short distance/same-room communication)

Strong Industry Support
(Major players from PC, Mobile & CE segments)

Instantaneous Docking/Synching (Peer-to-peer)	Internet Access (complementing 11ac)	High-Performance Wireless Display/Audio (Uncompressed transfer, Peer-to-peer)

Industry’s first tri-band WiGig solution

- Tri-band - 2.4, 5 and 60 GHz
- 10x more in-room performance*
- Seamless transition with 11n & 11ac
- Commercial now (PC/Docking Station)

Dell Latitude 6430u, world’s first WiGig device – built on Qualcomm Tri-band solution

Combining Qualcomm’s VIVE™ 11ac solutions with Wilocity’s 802.11ad

Precise indoor positioning – Using Wi-Fi, sensors and more

Wi-Fi network based determination

- Signal strength and delay measurements
- Accuracy 5-7 mts

Device-based determination

- Signal strength and delay measurements
- Sensor augmentation
- Accuracy 3-5 mts

End-to-end solution provides highest accuracy and reliability

Qualcomm IZat™ – Precise positioning everywhere

Comprehensive end-to-end solutions

1st to market with
GPS + Glonass

Always-ON indoor location with
near-zero power consumption

Indoor Location Solutions
(inlcuding cloud based data bases & services)

Satellite-Based
GNSS Solutions

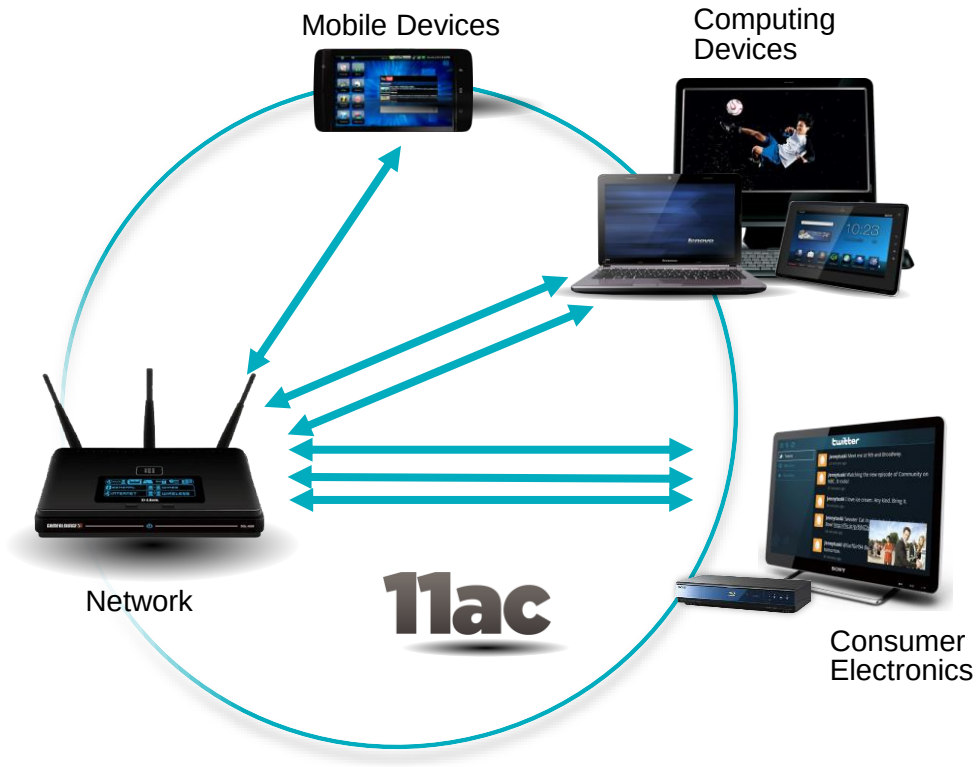
Qualcomm IZat™

Augmentation Technologies
(Cellular, Wi-Fi, Sensors, Servers)

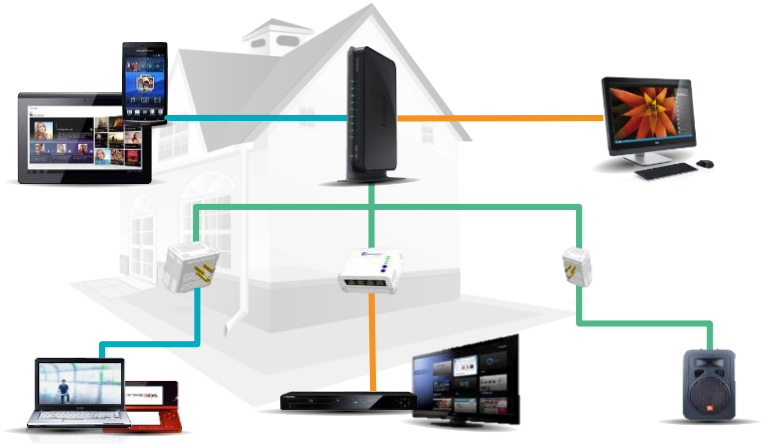
Integrated into all MSM, MDM and APQ platforms
(and discrete solutions)

Qualcomm: Wi-Fi evolution leadership

Enabling robust end-to-end 11ac Ecosystem



Comprehensive connected-home solutions

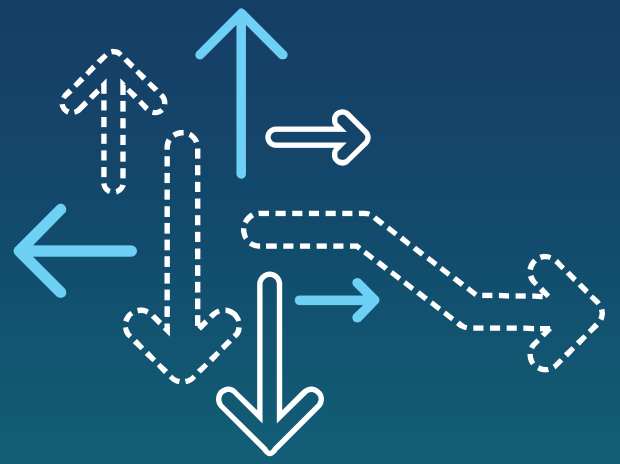


Trendsetting in-door positioning & WiGig offerings

Qualcomm IZat™

Industry leading solutions with end-to-end excellence

Questions? - Connect with Us



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